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ABSTRACT

This study is an investigation of the responses of four Colorado school districts to a set of standards-based education (SBE) policy instruments that originated from the National Council of Teachers of Mathematics (NCTM), the state of Colorado, and the federal government. The paper first describes Colorado standards-based mathematics reform policy which has three sources: (1) NCTM documents; (2) federal education policy; and (3) state education policy. Interviews, first-hand document collection, classroom observations, and observations of teacher training were the data collection methods used. Findings suggest that for SBE reform to significantly impact math classrooms, states and districts will need to provide more opportunities for teachers to understand NCTM's vision of SBE reform, additional time and quality professional development that allows teachers to make such fundamental changes, and assistance in alleviating other pressing problems, particularly in lower achieving, lower socio-economic districts. (Contains 57 references.) (ASK)

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Local capacity and state policies in Colorado:

Obstacles to standards-based mathematics education reform

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> The continuing and ultimate challenges lie in bringing the kinds of changes outlined in Goals 2000 and standards-based reform to the classroom level -- in all classrooms across the country (U.S. Department of Education, 1998a, p. 25).

This statement, contained in the 1998 Goals 2000 Report to Congress, indicates the Department of Education's recognition that standards-based education (SBE) reform will succeed or fail based on the extent of implementation in the classrooms of an estimated 2.8 million teachers across the nation (National Center for Education Statistics, 1999, p. 4).

SBE is the 1990s version of a series of reform policies intended to improve schools. SBE calls for a fundamental change in both what is important for students to learn and how teaching and learning occur. In mathematics, the National Council of Teachers of Mathematics set forth a series of documents specifying the vision and details of reformed mathematics education. NCTM acknowledged that adoption of the math standards was only a first step in the change process. The NTCM vision of the reform specified that mathematics education should build on students' existing knowledge and should develop students' mathematical power. This included several things, such as understanding mathematics, reasoning, valuing mathematics, seeing connections within mathematics and across content areas, developing confidence, and using communication as a tool to convey mathematical ideas and enhance students' own learning. The reform includes both what is taught and how it is taught. A central tenet is that mathematics is for *all* students; no longer would it be acceptable for some or even most students to succeed in mathematics. The reform upholds learning as an active process, a social process, and a process that builds on what students already know.

This study was an investigation of the response of four Colorado school districts to a set of SBE policy instruments that originated from NCTM, the State of Colorado, and the federal government. The research problem was that although there was much rhetoric about this reform, there was little evidence that SBE produces the intended results or about its possible unintended results. This study was undertaken to contribute to the limited knowledge base

about what happens inside of districts, schools, and classrooms as SBE policies are set into motion. This problem led to the formulation of the research question, "What obstacles did four leading Colorado school districts face when implementing SBE reform in mathematics, and how did they overcome them?" The intention was to determine whether the enactment of the reform was consistent with the vision of it and to explore implementation difficulties in each setting.

Colorado Standards-Based Mathematics Reform Policy

Standards-based mathematics education reform in Colorado has three sources: National Council of Teachers of Mathematics (NCTM) documents, federal education policy and state education policy. Each of these sources has put forth a different type of policy instrument (McDonnell & Elmore, 1987) with varied levels of authority, detail and financial support. In this overview of SBE policies, I use these three characteristics (detail, financial support, and authority) to describe, compare, and contrast them.

NCTM Documents: A Source of Detail

In 1986, NCTM established the Commission on Standards for School Mathematics and charged it with creating three sets of standards: K-12 mathematics curriculum standards; standards for evaluating school programs; and standards for student assessment (Webb & Romberg, 1992). NCTM specified that the curriculum standards would incorporate both the mathematics content and the instructional conditions necessary for a quality mathematics program. NCTM stated its vision for K-12 SBE mathematics as follows:

- Mathematical power for all in a technological society;
- Mathematics as something one does – solve problems, communicate, reason;
- A curriculum for all that includes a broad range of content, a variety of contexts, and deliberate connections;
- The learning of mathematics as an active, constructive process;
- Instruction based on real problems;
- Evaluation as a means of improving instruction, learning, and programs. (NCTM, 1989, p. 255)

The vision calls for a fundamental change in what happens inside a mathematics classroom and in the spirit of how mathematics is taught.

NCTM documents provide more detail than the other policies but do not have formal authority or financial support. The NCTM documents, authored by the major professional organization of K-12 mathematics educators, rely on professional norms and the power of persuasion to implement the reform.

Goals 2000: A Source of Seed Money

Goals 2000 (Sec. 102, 1994), the federal policy instrument, is an inducement policy tool (McDonnell & Elmore, 1987) that the federal government uses to encourage states and districts to pursue SBE. Goals 2000 does not carry the legislative authority to mandate compliance; instead it offers federal seed money (albeit limited) to state and local units to gain their participation. As the title "Goals 2000" implies, ambitious national goals were to be achieved by the year 2000, including student mastery of challenging subject matter in English, mathematics, sciences, and six other content areas.

Colorado State Policy Instrument: A Source of Authority

The state policy instrument, Colorado Education Reform of 1993 (also commonly referred to as House Bill 1313 or H.B. 1313), is a mandate in McDonnell's and Elmore's terms. As such, it requires that all Colorado school districts and the Colorado Department of Education comply, and legislates deadlines for the completion of specific activities (Education Reform, 1993). This mandate does not provide financial resources to the school districts to implement reform activities, and specific details about the reform are limited.

H.B. 1313 requires school districts to redesign curriculum, instruction, testing, and teacher development to meet challenging academic standards. These content standards were to focus classroom activities in eleven areas: mathematics, science, reading, writing, history, geography, civics, art, music, physical education, and foreign language. By identifying targets of what students should know and be able to do at three stages in their schooling (grades 4, 8,

and 12), these content standards were intended to "provide the opportunity to more closely link what is expected of schools, what is taught in schools, and what is assessed in schools, thus giving the public a more reliable way of evaluating schools' performance" (Standards and Assessment Development Implementation Council, 1995). Within this state policy, districts had discretion to determine the function that tests serve to support SBE and the choice of district assessments as well. The policy mandated that the state develop a set of model content standards and district standards must then be at least as stringent.

The Colorado Model Content Standards for Mathematics are as follow: 1) students develop number sense; 2) students use algebraic methods to explore, model, and describe patterns and functions; 3) students use data collection and analysis, statistics, and probability; 4) students use geometric concepts, properties, and relationships; 5) students use a variety of tools and techniques to measure; and 6) students link concepts and procedures as they develop and use computational techniques. Each of these six standards specifies that students be able to apply their skills and knowledge in problem-solving situations and communicate the reasoning used in solving these problems (Colorado Department of Education, 1995).

Completing the Colorado H.B. 1313 reform package was the requirement that Colorado develop a statewide standards-based student assessment program. The Colorado Student Assessment Program (CSAP) was established and the first CSAP assessments were administered to fourth graders in reading and writing in Spring 1997 (Colorado Department of Education, 1998b). CSAP consists of a mixture of criterion-referenced test items in three formats: multiple-choice, constructed response, and extended response. Results are reported according to four performance levels (advanced, proficient, partially proficient, and unsatisfactory). The assessment schedule calls for the addition of grades and subject areas over the course of five years, at which time CSAP will be complete. The CSAP is aligned with the model content standards developed by the state.

In addition, other state policies were recently implemented in Colorado that affected the ways that school districts could receive and spend money. Specifically, the Colorado TABOR Amendment of 1992 and the Colorado Public School Finance Act of 1994 are notable for their impact on district financial resources. The TABOR Amendment to the Colorado Constitution limited the ability of governmental entities, including school districts, to increase their spending beyond the amount of inflation and required prior voter approval before imposing new taxes. The Public School Finance Act, an attempt at equity in district per-pupil operating revenue, ensured a minimum threshold for per-pupil revenue ($4,305 in 1997-98) through state contributions to districts. However, the Act did not eliminate the disparity between districts spending the state minimum and those spending the most, in excess of $9,000 in 1997-98 (Colorado Department of Education, 1998a).

Summary of Policy Instruments

The nation has embarked on an ambitious educational reform agenda, through Goals 2000. The state of Colorado has enacted ambitious legislation for educational reform as well, through H.B. 1313 and other avenues. Both the federal and state policies are specific about the ends they envision but vague about the means of getting there. Contributing to the impetus for reform, NCTM has published documents that are more specific than the legislation, articulating the vision and philosophy of the reform for mathematics education. These policies intend to change the way that teachers and students act in classrooms.

Conceptual Framework

A variety of perspectives have been developed by educational researchers to understand the complex and non-linear process of implementing reform policies. Researchers recognize that changing the entrenched and enormous system of public education is more complicated than simply issuing a mandate and waiting for compliance. Filtering policies down through many tiers of government takes time and inevitably results in variation as each agency

interprets the policy differently, and each teacher interprets the policy differently (Cohen & Ball, 1990b; Spencer, 1996). Teachers are not passive recipients of reform; rather they adapt current reform ideas in varied and creative ways. As a result, the reform is likely to vary from location to location (Odden, 1991). Some of the frameworks for understanding the reform process have emphasized the role of local education agencies (Odden, 1991); the role of teachers' thoughts and beliefs on teachers' behaviors (Shavelson & Stern, 1981); the coherence of the reform (Fullan, 1991, 1996; Lipsky, 1980); the degree of change involved in the proposed reform initiative (Chubb & Moe, 1990; Cuban, 1988; Odden, 1991); and the source of the reform initiatives, whether it be top-down or bottom-up or somewhere in between (Darling-Hammond, 1990).

In addition to these approaches, two models for examining educational reform have recently emerged that emphasize potential reform obstacles specific to local education agencies and state and federal policies. Both models attend to the need for appropriate teacher training, particularly in light of the ambitiousness of the reform and the fundamental changes it would require in the approach to teaching mathematics with regard to knowledge about mathematics, knowledge about teaching, and knowledge about learning. The first framework is a transaction-cost appraisal perspective that is based on the assumption that successful educational reforms must take into account at least three elements: the rational limits to teachers' knowledge and skills, human tendencies toward opportunism, and the substantial investments teachers have in their teaching assets (House, 1996, 1998; House & McQuillan, 1998). The second framework I draw upon theorizes that the capacity of the local school district is crucial to successful reform, although probably not sufficient. Spillane and Thompson (1997) define local capacity as being comprised of these three elements: human capital, social capital, and financial resources.

While both the local capacity and transaction-cost models are based on economic theory, they operate independently: a district may or may not have the capacity to implement and sustain a reform, and a federal or state reform policy may or may not have the proper

criteria for success. The local capacity theory considers the *investments of the local school district* to predict success of the reform and the transaction-cost appraisal theory considers the *costs to individuals and whether policies compensate for these costs* to predict the success of the reform. Although both theories view the reform from an economic perspective, they offer different ideas about potential obstacles to the reform. Both theories were considered in this study because if both the state and federal policies and local capacity were inadequate, the reform was likely to fail. It was assumed that *either* state and federal policies must contain sufficient elements for a successful contract *or* local capacity must be sufficient to carry off the reform (*or both*), for reform to occur. Next, I discuss the three potential obstacles to reform policies that each framework posits.

Transaction Cost Appraisal Framework

This model treats the reform policies as contracts entered into by the policy-makers and the policy-enactors (i.e., educators). Recently, House (1996, 1998) and House and McQuillan (1997) have imported ideas from a branch of economic theory, transaction-cost economics (cf. Williamson, 1985), into educational research to predict or appraise the likelihood of success of educational reforms. The model poses at least three critical attributes of a successful contract for education reform. The successful contract would acknowledge and compensate for educator's 1) bounded rationality, 2) opportunism, and 3) asset specificity. The transaction-cost model hypothesizes that teachers need to know how to do what the reform asks of them, have some motivation for implementing it, and feel assured that the reform is sound (i.e., worth an investment). It examines these attributes from a policy level.

Bounded rationality is critical because it is this aspect of the reform that recognizes that the people who are supposed to implement the reform, the educators, are not all-knowing, i.e., bounded rationality is the component of the reform that points out the need for special training. House (1996) wrote, "Just because one can specify a task doesn't mean that humans can accomplish it. They may lack sufficient knowledge or ways of acquiring the necessary

knowledge" (p. 6). As House indicated, bounded rationality does not assume that educators are ignorant or incapable, but rather that there is a limit to what they know and can do. (In fact, he also noted that teachers are more highly educated than the general public.) The extent to which teachers know how and are able to teach the math standards, and the extent to which the SBE policies compensate for deficiencies link bounded rationality to this study.

Sound contracts must also control for opportunism, the natural human tendency to pursue self-interests. Opportunism can vary in degrees, being aggressive at one end of the continuum to merely not being obedient at the other end. To say that a reform needs to attend to opportunism is not to say that educators are completely self-seeking. It merely means that when stakes are high and opportunities to act in one's own best interest arise, individuals may take these opportunities. Examination of the extent to which teachers adopt the reform's goals or substitute their own, and policies about rewards and consequences for teachers link opportunism to this study.

According to this theory, while bounded rationality and opportunism are assumed to be inherent in human nature, asset specificity is a principal dimension along which contracts may differ. Education is a highly asset-specific situation because deeply specialized skills are involved and these skills are specific to a particular situation. For example, particular teachers have investments in particular students, parents, and each other and as a result of these relationships teachers can not be replaced by other teachers without cost.

In addition, teachers have non-trivial specific personal assets, such as teaching skills, knowledge, and experience. Teachers do not acquire their expertise easily and are reluctant to abandon it, particularly when they are not convinced that the reform's teaching methods are sound. The personal costs associated with changing their behavior are high. Most educational reforms are not well conceived by reformers, and this is apparent to teachers (House, 1998). Thus teachers are likely to balk at pressure to change their practices with each new educational reform. They make rational responses based on the expected costs and benefits. House noted

that "to get them to change requires more than just rhetoric" (p. 88). If a reform asks them to teach differently and develop new materials – to move away from old routines – they will be resistant because not only does this require them to learn the new methods but also give up the expertise they have already developed. These are significant costs for teachers. Thus teachers may simply adopt pieces of the reform that they already know how to do. The extent to which policies propose sound and convincing reforms and the extent to which teachers' expertise and skills are valued link the concept of asset specificity to this study.

Local Capacity Framework

The second framework deals with capacity of the local school district to implement reforms. Spillane and Thompson's (1997) model places local educators at the center of the reform activities and investigates whether there is enough capacity to facilitate and lead challenging endeavors. In 1975, Becker, an economist, expanded the notion of capital (previously restricted to physical or labor capital) and applied it to human capital. Becker's notion of human capital referred to investments in people, specifically educational investments. Education was broadly construed to mean both formal and informal learning, such as on-the-job training, high school, and college. Several years later, Coleman (1988), a sociologist, built upon Becker's ideas of human capital and defined the concept of social capital. He wrote:

> Social capital is defined by its function. It is not a single entity but a variety of different entities, with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors – whether persons or corporate actors – within the structure. (p. S98)

Merging Becker's and Coleman's ideas, Spillane and Thompson asserted that three types of capital – human, social, and financial – are necessary, but not sufficient, for successful ambitious reform such as that promulgated by NCTM. They defined the three categories in the following way:

- Human capital refers to the commitment, disposition, skills, and knowledge of local reformers.

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- Social capital refers to collegiality, collaboration, trust, and professional networks, i.e., the social relationships among those in an organization; and
- Financial resources refers to the allocation of resources to provide staff, time, and materials.

Human capital is the individual's ability and willingness to do what is asked. Social capital is related to human capital but differs in that it is socially constructed, requiring interaction among the individuals. Spillane and Thompson described human capital and social capital as intertwined and dependent upon each other, explaining that human capital is developed through social capital. Social capital has a "public good aspect" (Coleman, 1988, p. S119), meaning that it not only benefits the individual but also all those who are part of that social organization. Social capital includes a variety of social relationships ranging from two-person interactions to large-scale professional networks. These authors distinguish between the close, causal relationship between human and social capital, on one hand, and financial resources, on the other hand. They contend that financial resources are extremely necessary but the extent to which successful reform depends on them relates to the level of human capital and social capital. That is, financial resources alone are not enough. Human and social capital together with financial resources provide fertile ground for reform.

Human capital and financial resources may be more familiar concepts than social capital. As an example of how social capital might play out in schools, Spillane (1999a) studied how successful teachers' (i.e., those that implemented the reform in a substantive way) practices differed from practices of their less successful colleagues. He wrote about the importance of teachers' enactment zones and the degree to which teachers worked in a social or an individualistic professional environment. He defined enactment zones as:

> [T]hat space in which reform levers meet the world of practitioners and 'practice', involving the interplay of teachers' personal resources with 'external' incentives and learning opportunities mobilized by policy, professional, private and other sectors. (p. 171)

Teachers' enactment zones vary along a continuum from individualistic to social, Spillane theorized. Teachers that had changed their mathematics teaching in fundamental ways had quite different enactment zones than other teachers studied. Successful teachers created and operated in a more social professional environment. They interacted regularly with both their colleagues and recognized experts. In addition, their social interactions involved deliberating about the reform ideas and discussing teachers' successes and failures in trying new ideas in their classrooms. Successful teachers' practices included using a variety of resource materials that were available to support the reform. It was the extent to which teachers' enactment zones involved social interactions with their peers and with recognized experts, the quality of these interactions, and the incorporation of new materials into their practices that made a difference. Spillane concluded, "If this conjecture turns out to be roughly right, it suggests that an exclusive focus on creating opportunities and incentives that target the individual teacher may be misguided" (p. 171). These pivotal elements of teachers' enactment zones are examples of what is meant by the notion of social capital.

METHODS

The primary research design was a multi-site case study with instrumental cases (Stake, 1995), meaning that they were purposefully selected to provide information about specific issues. The intent of the study was not to produce grand generalizations from sample to population, but to understand and describe the particular cases and their issues (Firestone, 1989; Stake, 1995).

Districts, Schools, and Individual Participants

Rather than seeking a representative sample of Colorado school districts, I was interested in studying districts that were likely to provide information about the difficulties and successes of reforming mathematics education, i.e., districts that were actively pursuing the

reform. As Stake said about his selection of six Chicago schools from among 500, "The principal criterion in selection of schools was less 'What schools represent the totality of Chicago?' but, rather, 'What group of schools will help us understand the problems facing school reform in Chicago?'" (1995, p. 5) The four districts selected for this study were recommended as leaders or "active users" (Firestone, 1989) in SBE and were considered to be likely to provide insights about district implementation processes.

The participating districts varied in size and type of community to a greater extent than they did in percentage of students receiving free or reduced-price lunch, percentage of minority students, or achievement as measured by the CSAP (Colorado Department of Education, 1996, 1998b). The number of students for each district was 1,200-6,000 for District D, 6,000-25,000 for District A and District B, and over 25,000 for District C. Two districts were in the Denver Metropolitan area, one district was in a major population area outside the Denver Metropolitan area, and one was an outlying town. One of the Denver Metropolitan districts differed from the other three districts in that half of its students qualified for free or reduced-price lunch, over half of its students were minorities, and it scored well below the state averages on the 1997 CSAP tests. In the other three districts, the percentage of students receiving free or reduced-price lunch and the percentage of minority students were below the state average, and student achievement was above the state average. (It was not possible to provide variety among all of these dimensions given the districts that were nominated as leaders in SBE reform. Most of those reputed to be SBE active-users were not low-income, high-minority, or low-achieving districts.)

Within the districts, active-user schools were sought, based on the recommendations of district administrators. In each district, one elementary school, one middle school and one high school participated, for a total of twelve schools participating. Within schools, active-user teachers were selected, based on the recommendations of principals. In addition to principal

recommendations, extra teachers participated as a result of snowball sampling (Lecompte & Preissle, 1993), i.e., through the recommendation of their colleagues.

Data Collection and Analysis

Qualitative methods were necessary for answering the research questions, which focused on gaining an understanding of and describing SBE reform in these sites. The chosen methods (face-to-face interviews, first-hand document collection, classroom observations, and observations of teacher training) were advantageous for tracing the effects of the reform to the ground-level. This included structured observations of the activities of teachers and students in math classes, and structured observations of teachers and administrators at professional development activities. Data collection occurred between September 1996 and May 1997.

I developed and used interview guides to ensure that I posed the same questions to all respondents while allowing the conversation to flow naturally (Patton, 1990). I used a similar, but not identical, interview guide for administrators, principals, and teachers. The interview guides contained questions to elicit a description of the following:

- The participant's understanding of standards-based mathematics reform;
- District processes to develop and implement content standards and benchmarks (district administrators only);
- District assessments and assessment policies (district administrators only);
- School-level changes in response to the reform including curriculum, instruction, assessments, and professional development (principals only);
- Classroom changes in response to the reform including curriculum, instruction, assessments, and professional development (teachers only);
- District-sponsored professional development;
- Stakes attached to achievement;
- Student interventions; and
- Problems encountered.

Sixty-nine educators were interviewed: fifty teachers, twelve principals and seven district administrators. All interviews were tape-recorded and transcribed.

A wide variety of documents were collected from all organizational levels. District and school documents included policies, assessments, and board and accountability committee

minutes. Many of the documents collected came from teachers and included syllabi, classroom assessments, assignments, and examples of student work.

Classroom observations provided examples in practice of what the teachers said during our interviews. I explained to the teachers that I wanted to see the impact that the math standards had had on their classroom, thus giving them an opportunity to demonstrate their understanding of the reform. Teachers were encouraged to select a class that they thought would be a good example of classroom changes that they had made. Thirty-three teacher interviews were followed-up with classroom observations. Fieldnotes were used to record observations.

Data analysis was conducted according procedures specified by Miles and Huberman (1994), specifically pattern analysis techniques. Data were coded and summarized in a variety of data displays (including matrices, tables, vignettes, and excerpts from transcripts and fieldnotes) in order to identify patterns and generate assertions (Erickson, 1986). Assertions were tested by examining confirming and disconfirming evidence, triangulation across sources and types of data, and, to a lesser extent, reactivity of participants.

RESULTS

SBE reform rhetoric calls for high, challenging standards for all students, and emphasizes that all students should have the "educational experiences needed to achieve the adopted content standards" (§§ 22-53-406 (2a), Education Reform, 1993). Although this was the intention of the Colorado legislation, results from this study suggest that the reform as it was enacted was not always consistent with these ideals. There were obstacles that stood in the way and these obstacles were not identical from district to district or school to school. Educators' responses to SBE reform (in terms of their classroom and administrative activities) varied according to their understanding of the reform and according to a set of contextual conditions (i.e., the extent to which obstacles were present in their setting). Specific

implementation problems included the following: many educators did not understand the intent of the reform; formal and informal teacher professional development opportunities were insufficient; additional time for teachers to develop new expertise was lacking; and local testing policies sent mixed messages about what was important for students to know and be able to do. I will briefly summarize these main results below.

Misunderstanding

There was great variability among educators' perceptions and practices in these school districts identified as leaders in SBE, even after several years of having standards in place. Administrators generally had better understandings of the reform than did either principals or teachers. Interpretations ranged from perceiving SBE as a curricular checklist, at one end of a spectrum, to understanding it as an intensive change in the way classrooms operate, at the other end.

Several teachers and a few principals showed "poor" understandings of the reform. Responses categorized as poor understandings were very simplistic or surface-level interpretations of the reform. About 23% of participants' responses were poor. These were mostly teachers (in fact, mostly elementary teachers) and one principal. Some teachers who misunderstood the reform had not made changes in their classrooms or had changed in ways not intended by the reform. For example, some thought that the reform was merely a re-organization of the traditional math curriculum or a checklist to make sure that the curriculum covered what the state wanted it to cover. Re-organizing and re-arranging traditional math content was a time-consuming activity that many educators took to be the essence of the reform, although these activities only scratched the surface of it. Topical alignment of the curriculum did little to ensure that students' classroom experiences were different.

Another group of educators held a partial understanding of the reform. The "partial" category came about because there were people that had more than a surface level

understanding of the reform, i.e., viewed it as more than a checklist, but fell far short of the vision for constructivist math education called for by NCTM. A large group of educators (33 of 69) displayed understandings that were in this category, mostly teachers (21 of 50) and principals (10 of 12). Three of the seven district-level administrators fell into this category. Thus, a large percentage of teachers and principals had at least some grasp of the reform, although it was incomplete and varied quite a bit from person to person. One of the most common partial understandings of SBE was that making one or two isolated changes in a traditional classroom would suffice. For example, common changes that teachers made, which they considered to be the essence of the reform, included more problem-solving activities; new assessments; using manipulatives; or adding statistics to the curriculum, but as an isolated topic. Some teachers took the reform to be equivalent to using new assessments, while other aspects of their math classrooms remained the same. Another example of a partial understanding of SBE was that some teachers said SBE was a call for higher-order thinking skills to the exclusion of meaningful basic activities. They thought that SBE eliminated the importance of computation, rather than simply down-playing the importance that it received in a traditional curriculum. Part of this was a misunderstanding of the role of calculators in the classroom, which some teachers perceived as an indication that students no longer needed to know how to add, subtract, multiply, or divide. This is contrary to the reform intention of achieving an appropriate balance between thinking processes and important knowledge (Resnick & Resnick, 1992).

A third group of educators reflected, by self-report and in practice, a "good" vision of the reform consistent with NCTM's proposal. About half of the district administrators were in this group, as were several teachers and one principal. This group included 29% of participants. This response is defined as fundamental changes in mathematics education, including a student-centered classroom, students actively involved in learning, building on the knowledge students already have, connections among mathematical topics traditionally treated as discrete

subjects (like algebra and geometry) as well as connections among content areas (like math, science, history, writing).

High school and middle school teachers more often had good visions of SBE than did elementary teachers. One reason more secondary teachers held good visions of the reform, compared to the elementary teachers, may be that they were more likely to be involved with NCTM and, therefore, more familiar with the standards. Secondary teachers taught only mathematics. They saw themselves as math specialists and as members of a community of mathematics teachers. The elementary teachers perceived themselves as generalists who taught across the curriculum. The elementary teachers saw themselves primarily as members of a community of elementary teachers.

Lack of Professional Development, Time, and Other Resources

Another primary obstacle to the reform was the extent to which local resources were available in each setting. Professional development and time were the two resources most commonly lacking. In addition, there was a set of other general resources that were in short supply but these circumstances were less uniform across settings than the need for professional development or additional time.

Professional development was an issue in all four districts, and at elementary, middle, and high school levels. Even in the district with the most extensive professional development program (1.5 hours per week), educators needed more. Some attempts at sustained professional development programs were made in two districts. However, more sustained and ongoing assistance was desired. Teachers particularly wanted help in designing, using, and scoring new forms of assessments. This was not very surprising given the emphasis on assessments leading the reform in some of these districts. However, virtually none of these educators claimed to need more education about mathematics itself. Many of the teachers most knowledgeable about the reform said that they were also involved in professional

development activities on their own time. This included taking graduate courses, teaching courses at nearby universities, and actively participating in professional organizations such as NCTM and Colorado Council of Teachers of Mathematics.

Another widely reported missing resource was time. Criticism of the time available to implement the reform cut across districts, educational levels, and positions also. At the elementary level, educators were confronted with numerous standards in several content areas. At the secondary level, although they taught only math, teachers kept track of standards-based achievement for several classes of students. Time inside the classroom and outside the classroom was too short. Educators said students needed more in-class time to become proficient in the math standards. They thought it was unrealistic for all students to master the standards within the existing school day structure, and knew that some students would need more time. One way teachers coped with this was to select certain topics, which they knew were on assessments, and spend more time on them at the expense of not-tested topics. Outside of class, teachers needed additional time to implement the reform too. They said they needed time reserved for interacting with their colleagues and developing appropriate units and assessments. They wanted this time to be provided during the school day so that all could participate. Teachers were skeptical about investing lots of time in the reform, particularly if they had seen past reforms fail.

Other general resources, as I am using the term here, include students, parents, teachers, services, and materials. These resources were lacking to different extents among the districts, unlike time and professional development issues, which cut across the districts. The differences between the lowest-income and highest-income districts were the most notable. In the lowest-income schools, student readiness was an issue because the challenging state standards were more difficult for students to attain than in other districts where student achievement was already generally high. In addition, in these schools students were highly mobile and often absent. Parents across all districts were largely uninformed or misinformed

about the reform. The result was that parents were not partners in the schools' reform efforts and in one case actively opposed it.

Local Practices

The third primary obstacle to the reform discussed in this report were local policies pertaining to student assessment and other infrastructures (e.g., scheduling, communication channels, calendar restrictions, and site-based management). All districts struggled with how to assess students' standards-based achievement and developed different assessment plans. Not all of their tests were consistent with the assessments called for by the reform. Each district continued to administer norm-referenced, multiple-choice tests and three districts also used criterion-referenced measures, which staff considered to be consistent with SBE reform. In two cases, the criterion-referenced measures were multiple-choice tests and in one case the criterion-referenced measure was a set of constructed response items. None of these measures contained a mix of item types. Relying solely on multiple-choice items made it doubtful that the math standards were measured sufficiently because some components of the math standards would seem to call for student-generated responses. For example, the standards require measurement of students' ability to solve problems, explain their strategies, and communicate mathematically. In addition, these particular tests emphasized basic math skills at the expense of higher-order math skills. Testing practices that rely entirely on multiple-choice items to measure standards-based achievement, emphasize computation skills, and/or report scores only in reference to other students' scores rather than in reference to academic criteria may send mixed messages to teachers, students, and parents about what is important. Such confusion could be another impediment to gaining broad support for the reform.

This is not to argue for abandonment of multiple-choice items in favor of purely constructed-response tests; this would be problematic as well. This was apparent in the one district that used only constructed-response items to assess the standards. These constructed

response assessments suffered from limited generalizability; that is, because there were few of these assessments, it was difficult to justify generalizations about student learning beyond those particular tasks. Thus, the validity of the inferences from these constructed response tasks about broad student achievement was questionable. A mix of item types (i.e., selected-response and constructed-response items) as well as a variety of sources of information for making high-stakes decisions would seem more appropriate.

Two districts used these tests to make high-stakes decisions about students. One problem that this created was the validity of these inferences. Another problem was the implication of the high-stakes assessment policies for changing teacher practices. The implied belief was that if consequences were serious enough, students' and teachers' behavior would change. In other words, the policy is based on the assumption that heavy outside pressure would be sufficient to bring about the necessary changes in teaching and learning. These high-stakes policies may be one way of compelling teachers to try to implement the reform, however, the pressure does not provide the ability to teach in reformed ways, understanding of the reform, or commitment to it.

DISCUSSION

With these results in mind, I return to the two frameworks that I introduced earlier in this paper to interpret the meaning of these results in the larger context of national, state, and local education reform.

Transaction-Cost Analysis of Colorado and Federal SBE Policies

According to the transaction-costs model, in order for educational reform policies to be successful the policies must address the obstacles noted earlier, namely that teachers likely do not know how to do what the reform asks them to do (bounded rationality); may not want to do what the reform requires them to do (opportunism); and probably will want to protect the

investments they have already made (asset specificity). In Colorado, the combination of current state and federal reform policies is not powerful enough to compensate for these obstacles to the reform. Colorado SBE reform is largely driven by the state law requiring districts to adopt content standards and state laws requiring certain outcomes on achievement measures. Education in Colorado has been and continues to be locally controlled. By requiring that districts adopt a set of content standards and measure local performance against those standards, the state provided more direction for curriculum and instruction than it has traditionally provided; however, compared to states with more centralized control, this was still a weak sense of direction. A slightly more powerful state direction comes from the state student assessment system, but this currently affects only grades 3, 4, 5, 7, and 8 in one or two subject areas per grade. According to Colorado statutes, local education agencies have control over curriculum and instruction. As such, the state allows local education agencies to decide the best course for translating the content standards into the required student achievement levels. State policies provide the external motivation and pressure for local educators to comply with the reform, but do not suggest curriculum, textbooks, or other avenues for local reform, nor does the state provide districts with additional resources for professional development. Although Colorado policies provide motivation, they do not attend to bounded rationality or teachers' asset specificity. In particular, needy districts do not receive any extra support for making the changes to their education systems. Colorado's school district finance law ensures a floor for per-pupil expenditures across the state, but this is a minimal amount. Colorado's per-pupil expenditures are among the lowest in the nation (Quality Counts '99). In addition, school districts must adhere to the TABOR Amendment that restricts their ability to raise and spend additional funds.

For example, one obstacle caused by policies that failed to address the fact that teachers have significant investments in their classroom routines was that teachers tried to "get by" in the standards-based environment by using the teaching skills that they already

possessed. A majority of the participating teachers incorporated aspects of SBE that they were comfortable with or that did not require much re-learning on their part. Several teachers enacted the reform by using more problem-solving activities in their traditional math classes, perhaps because such activities were already part of their asset-specific repertoire. Results indicate that there was a need for better understanding of the reform as well as professional development for teachers to develop the skills and materials to enact it in their classrooms. Although the state policies provided motivation for educators to increase student achievement on standards-based indicators, they did not provide avenues to increase teachers' knowledge and ability.

Also impacting the state policy environment are federal education reform policies. Primarily, this has been Goals 2000 and the proposed reauthorization of it, the Educational Excellence for All Children Act (Educational Excellence for All Children Act of 1999). Goals 2000 does not provide specific guidance about the vision for the reform; states and local educational organizations are expected to provide this direction.

Taken together, Colorado and Goals 2000 reform contracts do not contain the necessary provisions, according to the transaction-cost model, for successful reform. Should President Clinton's proposed Educational Excellence for All Children legislation be adopted, federal policy would provide more guidance and funding with an emphasis on low-performing schools.

In order to provide a reference point for what a successful reform policy might look like, I next present state policies from California and Kentucky, states that are locales of early SBE reform as well as leading examples of changed state policy (Cohen, 1995). In contrast to the Colorado state policy, California and Kentucky state policies differ in one important way: they recognize the need for and provide resources for teacher professional development.

California State Policy

Educational reform began as early as 1985 in California with the publication of curricular frameworks in several subjects, including mathematics. Although most aspects of California's

reform policies have undergone substantial revision since that time, one aspect of state policy that remained consistent was the attention to teacher professional development. According to the state legal codes, the University of California has the responsibility to establish and maintain subject matter projects in mathematics, among other content areas. These projects have several purposes, including to: develop and enhance teachers' subject matter knowledge and instructional strategies, maintain subject-specific professional communities that create ongoing opportunities for teacher learning and research; and create teacher-leaders with expertise in both the classroom and certifiable levels of content knowledge for the purpose of providing ongoing professional development to others in their schools and districts (California Education Code). Particular attention is paid to low-performing schools. Seventy-five percent of participants must be teachers from schools that achieve in the bottom forty percent of all California schools as measured by the state tests.

Despite attention by California state policy to curriculum, assessment, and professional development, studies of classrooms in California reported that the reform was still not pervasive as of the early to mid-1990s (Carlos & Kirst, 1997; Cohen & Ball,1999). Some of the obstacles standing in the way included that curriculum, assessment, and professional development reforms were not well aligned; there was a time lag between the curriculum development, assessment changes, and textbook adoption; and the professional development activities were uneven and operated on limited resources.

In California, the existence of a policy for professional development was necessary but not sufficient to compensate for bounded rationality and asset specificity. Funding and implementation of the policy were also crucial. Particularly notable was California's attention to the teachers in the lowest achieving schools.

Kentucky State Policy

Although education had traditionally been under local control in Kentucky, in 1990 the Kentucky Supreme Court ruled that the existing state schools were inequitable and placed more

responsibility for education with the state department. The Kentucky Department of Education was charged with carrying out the state reform package, the Kentucky Education Reform Act or KERA (Bridge, Winograd & Petrosko, 1996). KERA made Kentucky one of the first states to pass legislation that addressed the need for professional development and that allocated resources for these activities. KERA generated at least two main statewide professional development initiatives: school-based professional development grants and regional service centers. The school-based professional development included, at a minimum, four six-hour days without students present for teacher professional development and planning. The emphasis with the school-based grants was to provide funds so that schools could decide how best to use them and promote on-the-job training for teachers rather than isolated workshops. In addition to grants to individual schools, the state department established nine regional service centers, each of which housed at least three full-time resource teachers and other personnel that provided a variety of services to the districts, schools, and teachers (Borko & Elliott, 1999). The Kentucky regional service centers trained teacher-leaders and intended these leaders to train other teachers in their schools and areas, a model similar to California's.

Research in Kentucky indicates that, in a few specific cases, schools have greatly benefited from the school-based grants and regional service centers (Borko & Elliott, 1999; Wolf & McIver, 1999); however, the general impact of the state policy has been less encouraging (Bridge, Winograd, & Petrosko, 1996; Stecher, Barron, Kaganoff, & Goodwin, 1998). In a study of exemplary Kentucky schools, researchers found and reported "images of the possible" (Borko & Elliott, 1999, p. 10). In these schools, the researchers reported that there was an atmosphere of family, that is, there were extensively developed human relationships among faculty, students, and parents (Wolf & McIver, 1999). In these extraordinary settings, staff maximized their use of state funds to build upon an existing structure of continual teacher learning. The interrelationships among the faculty and the ongoing development of the faculty were essential elements of these successful schools and state policies helped sustain them. In contrast to this

study of exemplary schools, findings from a recent statewide survey indicated less encouraging results (Stecher et al., 1998). Most Kentucky teachers participating in that survey did not find the state professional development opportunities to be very influential aspects of the reform. Additionally, a summary of studies on the Kentucky reform (Bridge et al., 1996) reported several problems with professional development, including that these opportunities were limited, of mixed quality, usually occurred outside the everyday routines of school, and lacked the follow-up, practice, and reflection needed to influence actual classroom teaching. Although Kentucky policies provided opportunities for teacher training, the extent to which schools were able to take advantage of these opportunities varied.

In summary, both California and Kentucky policy contracts mandated the establishment of and provided resources for professional development. These provisions held potential for the overcoming teachers' need for training and teachers' reluctance about the reform. State policy in Kentucky provided funding at the school level as well as for regional centers, making it more comprehensive than California's policy. Even this level of state support, however, was not sufficient enough to overcome implementation problems. It is not surprising, therefore, that educators in Colorado, operating under less-comprehensive state policies, faced implementation problems.

Independent of state policies, it is possible that local education agencies would have the capacity to overcome implementation problems on their own. Next I discuss the study's results in terms of the local capacity framework.

Local Capacity Analysis of Colorado School Districts

In this study, human, social, and financial capital existed to differently degrees in each district. As a result, each district's capacity to overcome implementation obstacles varied. The limited knowledge of the educators (particularly at the elementary school level) about the reform and how to implement it was an example of inadequate human capital. In addition, parents'

knowledge about the reform was limited. Average student achievement, a third form of a district's human capital, varied considerably across districts. One of the reasons for the limited human capital at some sites was because social capital was lacking; in all sites opportunities for teachers to interact professionally were quite restricted. In the district with the most professional development opportunities, professional development was still insufficient to bring about the level of change in teachers' knowledge and skills. Time for teachers to work together is another example of social capital that was inadequate. District communication channels, another opportunity to develop social capital, also were weak.

One form of social capital explicitly noted in the model and supported by this study was the use of professional networks to develop collegiality and as a forum for exchanging information. Many of the teachers that had the human capital necessary to enact the reform in their classrooms were connected to professional networks, such as NCTM or the Colorado Council of Teachers of Mathematics, or linked with other education professionals through university programs. The idea of relying on professional networks to bring about such changes has support in educational literature (Education Commission of the States, 1995; Haug & Marion, 1996; Marsh & Odden, 1991; McDonnell, 1991; McLaughlin, 1991; Spillane & Thompson, 1997). In each case where a teacher was active in a professional network, this involvement was due to the individual teacher's initiative rather than being sponsored by the district's professional development programs. Educator professional networks are an example of one aspect of social capacity-building that teachers can take advantage of on their own, regardless of local or non-local policies. While such individual motivation occurred among study participants, it was restricted to a few teachers. In order to bring about broad-based ambitious reform, it seems impractical to rely on individual teachers' initiatives to participate in such networks. Instead, it seems that local districts should play a role in facilitating the participation of teachers in professional networks.

According to the local capacity framework, SBE policies stood to have the greatest negative impact on capacity-poor districts. This theory maintains that because of the close relationship between human and social capital, it is possible to create momentum between them. Local education agencies with strong existing capacity in one or both of these areas will generate more capacity, and those with little existing capacity will generate comparatively less capacity. They predict that without policy consideration for equity in these areas, those with capacity will likely succeed and those without will likely fail. In other words, if equity is ignored, the capacity-rich will get richer and the capacity-poor will get poorer. In this study, the low income, low achieving district also had the fewest human capital, social capital, and financial resources. This is the district in the study where a disproportionate percentage of poor and minority students attended school. It faced problems of poor attendance, too many drop-outs, and high rates of staff turnover – issues less salient in the other three districts. In addition to these pressing problems, this district also had to contend with making more progress in student achievement to measure up to the state standards than did the other three districts. Relying on local capacity to bring about the reform without attending to existing inequities makes it even more difficult for the least advantaged students to succeed in the standards-based environment.

In summary, state policies combined with local capacity of school districts was sufficient for successful reform in certain cases with select teachers but these circumstances did not exist in most schools and districts in this study. As a result, standards-based mathematics reform was unevenly implemented. Underlying the state and local policies were implications about teachers as learners, a topic that bears on conclusions that might be drawn from this study.

CONCLUSIONS: TEACHERS AS LEARNERS

I began this paper with an acknowledgement from the U. S. Department of Education that classrooms are the locales of change. Teachers are the main players in that arena and unless they understand and support the reform, classroom changes cannot happen. Interpreted

through the lenses of two economic theories, this situation might be presented as follows. The standards reform policies are contracts between reformers and local educators. These contractual arrangements (policies) should provide the necessary resources for the contract to be fulfilled. In Colorado, however, the contracts did not provide the necessary resources to overcome these problems. Additionally, the local school districts did not uniformly have the capacity (human capital, social capital, and financial resources) to overcome these obstacles on their own. As a result, because neither the policy nor every local district could compensate for these deficiencies, the reform contract was not likely to be successfully carried out as intended, at least not across all districts. Some districts had more local capacity than others did.

An implication of both the transaction-cost and local capacity frameworks is that teachers' needs must be attended to if the reform is to succeed. After all, teachers are the front-line workers (Lipsky, 1980) upon whom the policy-makers rely to carry out the policies. In order to put the policies into action, many teachers will need to be motivated to change as well as enabled to make the necessary changes to teach mathematics in fundamentally different ways. This implies that consideration should be given to teachers as learners. If current learning theories are applied to teachers (as they are to students in SBE reform), then teacher learning will involve context-dependent, social processes with which teachers are actively engaged (Resnick & Resnick, 1992). Further, teachers should be allowed and encouraged to develop a deep understanding of the reform such that it is not reduced to a simplistic activity for them, such as adding a new math topic to their existing math courses. Joyce and Calhoun (1995) pointed out, "Staff development must not be offered as, 'Here is stuff that has been researched, so use it!'" (p. 54). Instead, teachers need opportunities to learn about the reform both functionally and epistemologically, and this requires that policy be designed to support teacher learning (Spillane & Zeuli, 1999).

Although SBE reform endorses constructivist beliefs about learning for students, state policies in Colorado and some district policies implied a behavioristic belief about learning for

teachers. Although such policies provide motivation to change – a significant element for successful reform – more than motivation is required. Both motivation to change and capacity to change must be cultivated. Spillane (1999b) noted that sanctions are effective for getting educators' attention, but that a certain threshold of local capacity is required in order to make the more substantive reform ideas feasible. Research has indicated that a more appropriate view of teacher learning, i.e., a constructivist approach, and corresponding teacher professional development would serve reform efforts better (Noble & Smith, 1994).

Findings from this study suggest that for SBE reform to significantly impact math classrooms, states and districts will need to provide: 1) more opportunities for teachers to understand NCTM's vision of SBE reform; 2) additional time and quality professional development that allows teachers to make such fundamental changes; and 3) assistance to alleviate other pressing problems, particularly in lower achieving, lower socio-economic districts. To address problems noted in this study, some specific ideas might include providing classroom-specific assistance to teachers; using incentives to motivate; convincing teachers that the reform is well-conceived and worth a substantial investment; making use of existing teacher professional networks and other social, collegial arrangements; and devising ways to involve elementary teachers, in particular, in the math reform.

One way to further examine SBE reform using these frameworks might be to consider schools that seem to excel at implementing the reform, particularly those that do so in the face of adverse circumstances. In Colorado, a handful of high poverty schools do extremely well on the state assessment and "beat the odds." If these frameworks are sound, we would expect to find that schools able to carry off the reform successfully not only provide professional development for teachers but, equally important, regard their teachers as assets and professionals.

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